Point Pleasant Civilian Landscape Geophysical Survey
HRP A2013NS100

Prepared for: Nova Scotia Department of Communities, Culture and Heritage
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and

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Prepared by: Jonathan Fowler
with Samantha Grant, David Jones, Grant Miller, Maggie Poliseno
and Yuri Suzuki
Saint Mary's University
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EXECUTIVE SUMMARY

A geophysical survey was conducted south of the Northwest Arm Battery on 2 November 2013 in an effort to detect a building depicted on an early 19th century map. The survey employed the EM38B by Geonics and was conducted as part of coursework for ANTH4827.1 Advanced Landscape Archaeology at Saint Mary's University. The survey results were inconclusive and did not detect any evidence of historical architecture. Nevertheless, our results suggest the EM38B functions properly over the magnetically challenging Bluestone Formation bedrock.

I would like to thank Nicole May and Stephen Rice at the Halifax Regional Municipality for supporting our work, as well as Samantha Grant, David Jones, Grant Miller, Maggie Poliseno and Yuri Suzuki for their work on the survey and data analysis. As ever, I tip my hat to my friend and colleague Duncan McNeill, who remains a patient guide in the wonderfully complex world of archaeological geophysics.

Grant Miller collects data while members of the survey team look on. Camera facing northwest.

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THE PROJECT

Background

This project grew out of coursework for ANTH4827, Advanced Landscape Archaeology, which was offered for the first time at Saint Mary's University in the fall semester of 2013. The course builds on ANTH3378, Landscape Archaeology, and requires students to engage in data collection in the field in addition to classroom study.

Figure 1: Site location map (North at top). SOURCE: 2007 Halifax and Area: Nova Scotia Cities and Towns. Oshawa: MapArt Publishing, p. 51. The survey area is circled.

Archaeological mitigation in Point Pleasant Park following Hurricane Juan in 2003 has resulted in a burst of research on material cultural remains associated with civilian and military activities on the southern tip of the peninsula (Schwarz 2005; Davis et al. 2008; Fowler 2011a; Fowler 2011b). Through this work, I became intrigued as to whether geophysical methods might shed any light on the vanished structures depicted on various colonial-era maps. An undated Royal Engineers plan - thought to date to ca. 1800 - provided us with the first target for what we anticipate to be a series of archaeological surveys at Point Pleasant (Figure 2). It is a large structure, perhaps a dwelling, situated immediately south of the Northwest Arm Battery. Rubber-sheeting this early map with a modern satellite image reveals an approximate location east of today's red-roofed gazebo (also known as the summer house) (Figure 3). A secondary aim of the research was to contribute to an ongoing study of our geophysical survey method in Nova Scotia's diverse geological regions. This was our first test of the EM38B on the southern portion of the Peninsula of Halifax, whose geological characteristics present certain challenges for magnetic methods.

Figure 2: Detail of "Plans of Several of the Batterys at Point Pleasant n.d. 1800," Nova Scotia Archives (NSA) REO v.1. North at top.

Figure 3: Overlay of Royal Engineers map with 2011 satellite imagery by Google Earth, using shoreline and Northwest Arm Battery as reference points. The area of high potential is circled. Scale 80m.

METHODOLOGY

Our geophysical surveys employed the EM38B, a ground conductivity and magnetic susceptibility meter manufactured by the Canadian firm, Geonics Limited. The instrument, which is powered by a 9V battery, contains a transmitter coil that generates a low-frequency electromagnetic field (the primary field). This field induces a secondary field in the ground, which is in turn measured by a receiver coil (Clay 2006:82; McNeill 2012). The strength of the secondary field relative to the primary field allows inferences to be drawn concerning the nature of the soil and its constituents (for a more detailed discussion, see Clark 1996; Dalan 2006; McNeill 1980).

The EM38B is a particularly versatile instrument because it collects two types of data simultaneously: a quadrature phase response (conductivity), measured in millisiemens per metre (mS/m), and an inphase response (magnetic susceptibility), measured in parts per thousand (ppt) (Gaffney and Gater 2006:43). Soil conductivity is a function of several variables, not the least of which is moisture, which in turn may be taken as a proxy for soil porosity and, consequently, the presence or absence of buried archaeological features. Assuming they are filled with loosely-compacted topsoil, back-filled pits or ditches may exhibit higher conductivity than the surrounding soils, while on the other hand buried stone features stand out as exhibiting lower relative conductivity. Magnetic susceptibility is also a function of many variables, among which we have found the presence of iron oxides and chemical changes associated with burning (the LeBorgne effect) to be particularly important (Clark 1996:99-101; McNeill 2013:1-3). The presence of mafic rock in colonial-era architecture in Kings County has made the EM38B the preferred instrument for detecting ploughed-out house sites in that part of Nova Scotia (Fowler 2006).

In vertical dipole mode (coils perpendicular to the ground) the EM38B effectively detects magnetic susceptibility to a depth of 50cm (Dalan 2008:4), which encompasses the plough zone as well as anything preserved immediately beneath, and conductivity to a maximum depth of 1.5m (Clay 2006:83), but most effectively to less than 1m (Dalan 2006:177). This depth of measurement is generally sufficient to detect the sorts of near-surface archaeological deposits commonly found in Nova Scotia.

Archaeogeophysical survey methodologies have been well-developed internationally (Clark 1996; Clay 2006; Dalan 2006; English Heritage 2008; Gater and Gaffney 2006) as well as locally (Fowler 2006; McNeill 2013; McNeill and Fowler 2013). In this instance we conducted the survey on 2 November, 2013 in mild temperatures (13 degrees Celsius), establishing a 15m x 20m survey grid using 100m tapes measuring from the gazebo as outlined in Figure 4:

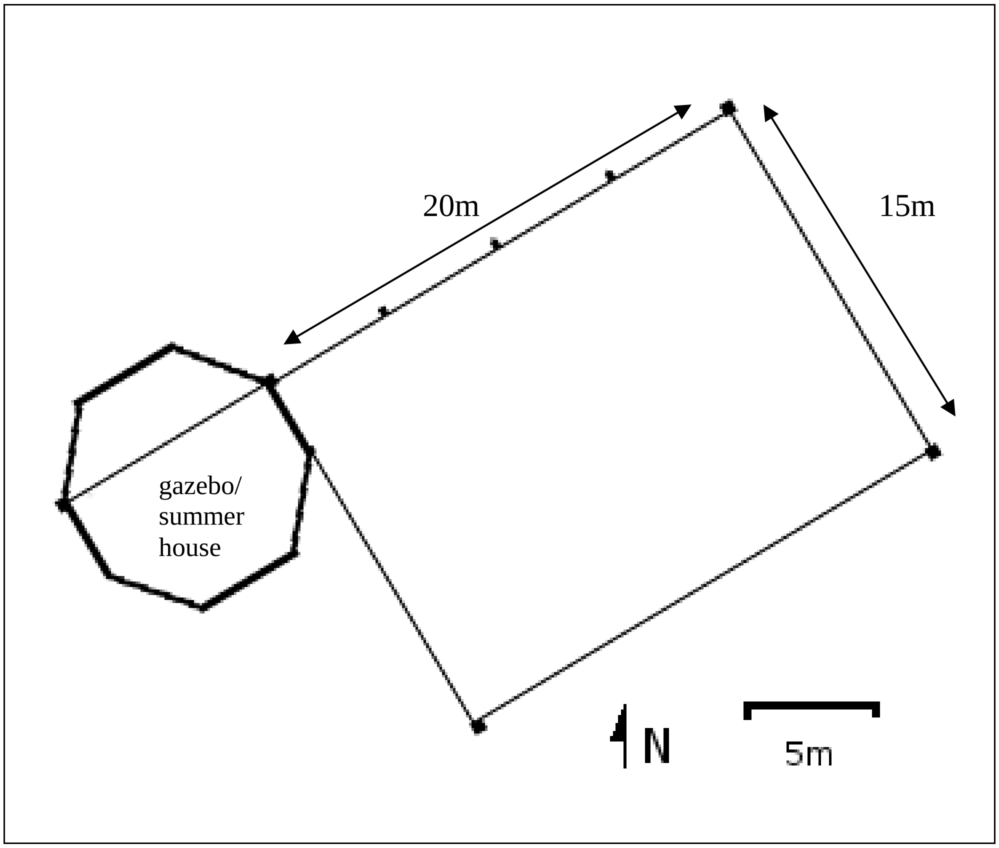

Figure 4: Location of survey grid with respect to gazebo. Our tape established the survey baseline (x = 0) by beginning at the upper lib of the cement base of the gazebo at its westernmost post. Aligned with the opposite post, the baseline passed off the cement base (lower lip) at the 9m mark. This point became the (0,0) co-ordinate of our survey grid.

Once the instrument was calibrated away from the survey area, data were collected in vertical dipole mode within a 20m x 15m grid using zigzag transects. The transects were oriented northeast-southwest and spaced at 1m intervals, with the start of line 0 at the NW corner of the survey grid (Figure 5). A guideline, flagged at 5m intervals and stretching from one end of the survey grid to the other, was employed to maintain spatial control, and inphase and quad phase data were collected with an Allegro CX Field PC at 5 readings per second (a mean of 340 readings per survey line, or approximately 17 readings per metre).

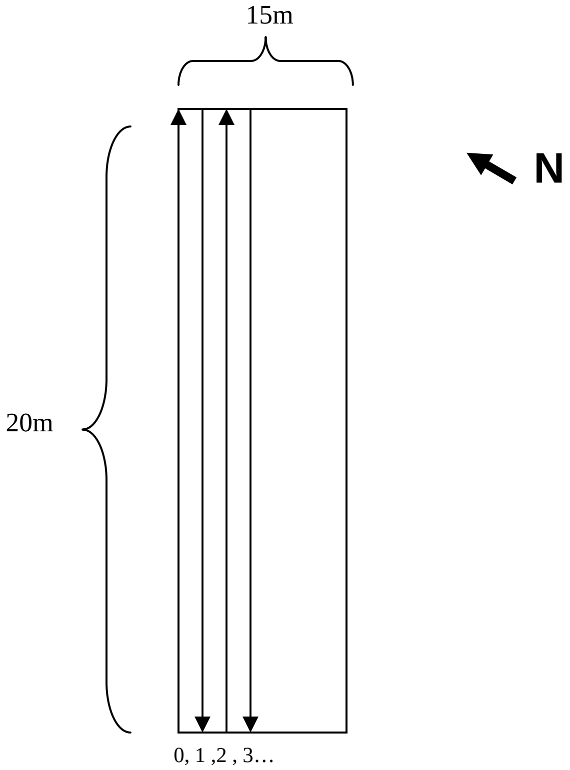

Figure 5: Idealized geophysical survey grid displaying orientation and zigzag transect geography. Not to scale.

Figure 6: Student Maggie Poliseno collecting data during the 2 November geophysical survey. The gazebo is in the background and the rampart of the Northwest Arm Battery is visible to the right. Camera facing west.

Following the survey, data were transferred from the Allegro logger and processed with DAT38BW (version 2.03) software by Geonics Ltd. and Surfer 8 software by Golden Software Inc. Both procedures are described in detail elsewhere (Geonics Limited 2002; Golden Software Inc. 2002), and are outlined as follows:

1. The raw data is converted from .P38 (logger) format to .B38 (processing) format.
2. Using DAT38BW software, survey geometry is corrected, converted to metric scale, and zero levels of inphase data are corrected for thermal drift.
3. Using DAT38BW software, separate XYZ files (.dat format) are created for inphase and quad phase datasets.
4. Using Surfer 8 software, the separate XYZ files are gridded and plotted to produce 2D maps of the survey results.

RESULTS

The survey results were ambiguous at best. We had expected our survey lines to bisect the structure depicted on the ca. 1800 map (Figures2 and 3, above), but no such linear features appeared in the data. Inphase (magnetic susceptibility) and quad phase (conductivity) data for each site will be treated separately.

Magnetic susceptibility

The most prominent anomalies in the inphase data (Figure 7) may be attributed to modern features within and adjacent to the survey grid. One large susceptibility anomaly at the northwest end of the grid can safely be assumed to relate to the gazebo, while a less extensive anomaly centered at grid co-ordinates (6, 16) is caused by a modern monument. The low results centered at co-ordinates (10, 17) are a result of survey logistics, as the instrument had to be lifted here to avoid a large tree stump. Beyond these results, the only somewhat interesting anomalies are the four areas of increased magnetic response near the centre of the grid, at co-ordinates (6, 9.5), (9, 10.5), (6. 5.5), and (9, 6.5). Their consistent magnitude and somewhat regular distribution is suggestive of design, but they could equally be natural in origin.

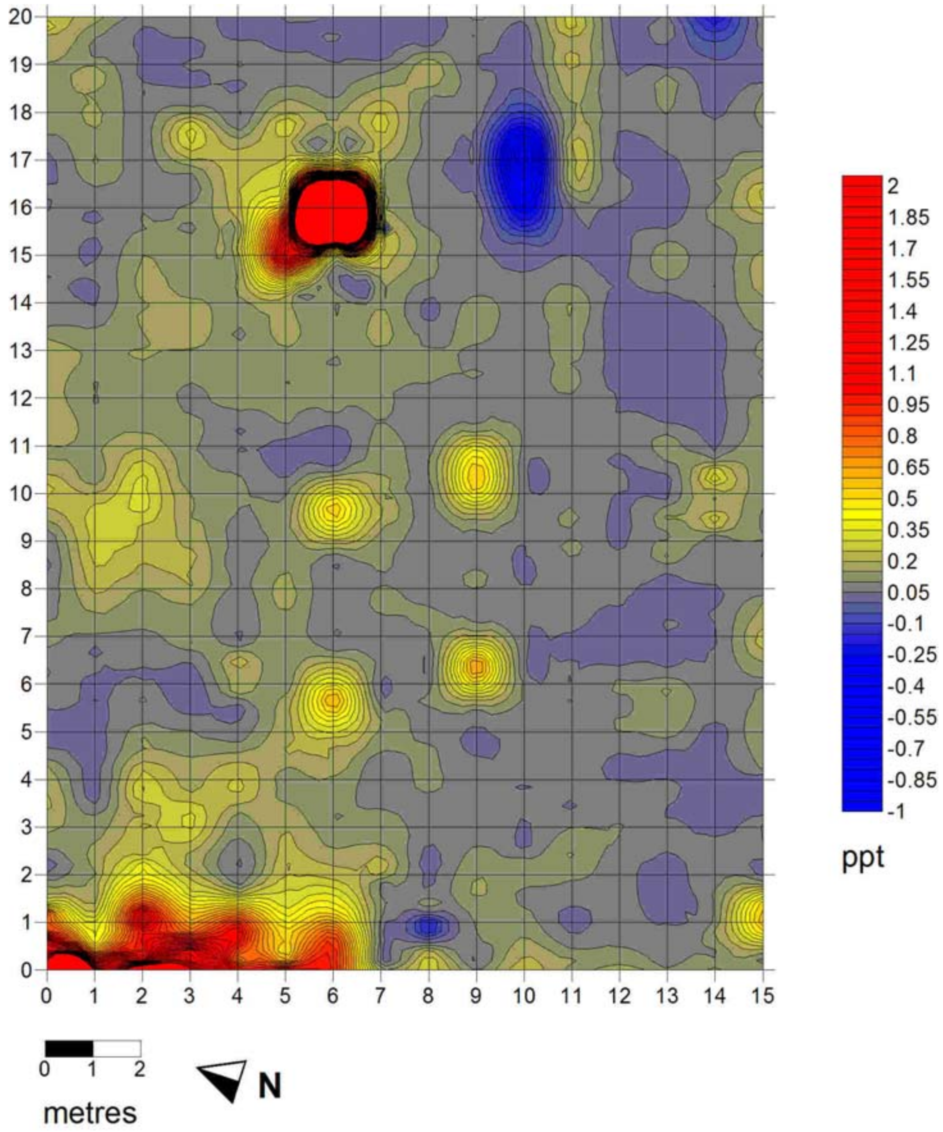

Figure 7: Inphase (magnetic susceptibility) results displayed as a contour map. The large anomaly at bottom left is associated with the gazebo, while the anomaly centered at (6, 16) is centered on a modern monument.

Conductivity

The conductivity response likewise reflects the presence of the modern park features noted above (Figure 8). Beyond this, the conductivity data seem to speak more generally to the underlying geology, with soils becoming gradually more conductive as one moves from north to south. The range of conductivity responses is consistent with soils in which sand predominates (Clay 2006:83). Sporadic lows in the conductivity data probably indicate the presence of buried stones, and the four localized anomalies that stand out so clearly in the susceptibility data appear as muted echoes here.

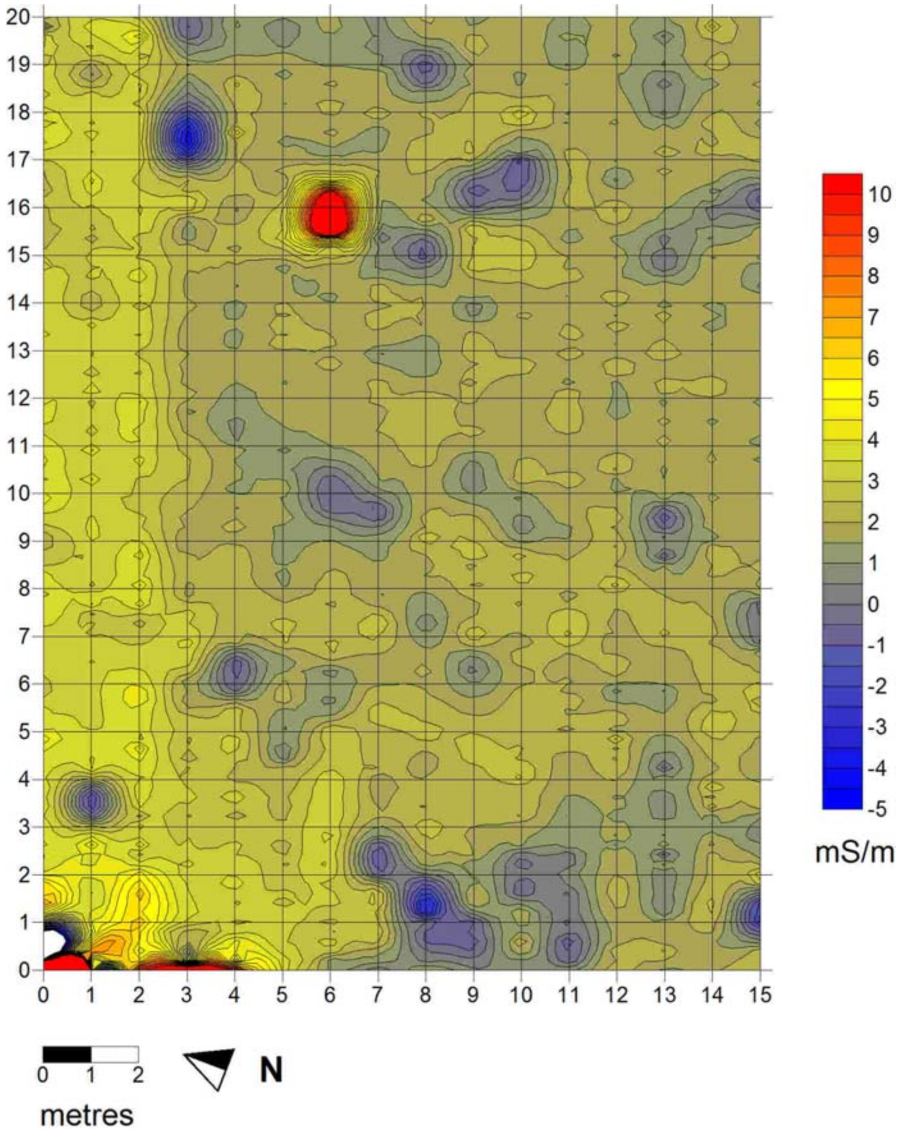

Figure 8: Quad phase (conductivity) results for the survey area displayed as a contour map.

PHYSICAL STATUS OF THE SITE

The site is currently a manicured lawn adjacent to a well used path. The eastern edge of the survey area trends into unkempt brush. This is municipally owned parkland and is under no immediate thread of development.

SITE SIGNIFICANCE

Owing to our ambiguous geophysical results, the significance of this site remains undetermined. There was no clear evidence of the kinds of geophysical anomalies we have typically found to be associated with architecture, especially in the inphase data.

ASSESSMENT OF RESULTS

Although predictions of geophysical survey viability based solely on geological considerations are problematic, and while "good results have been achieved over slates" in Britain (Gater and Gaffney 2006:78-79), our expectations going into this survey were mixed. The bedrock beneath Point Pleasant Park is no picnic for geophysical instrumentation, as it consists of metamorphosed slates of the Meguma Group, Halifax Formation.[1] Geologists have detected significant concentrations of magnetic minerals in this slate (up to 60% of sample volume), albeit from samples taken outside of Point Pleasant (King 1997:125), and "[s]ignificant total field magnetic anomalies are known to be associated with the Halifax Formation... with amplitudes varying between 300 and 600 nanotesla over thick slate units" (Howells and Fox 1998:212). Nearly two centuries ago, the polymath Titus Smith noted the magnetic effects of the "slatly soils" around Halifax, over which "the magnetic needle is very frequently turned from its proper direction: the error does not often exceed two or three degrees, but has been sometimes observed to amount to ten" (1836:590). Ambient magnetic variations of this size are as much as three orders of magnitude greater than those exhibited by archaeological anomalies visible to magnetometers. Nevertheless, the EM38B appeared to function normally and yield data consistent with that obtained from other parts of the province. That our instrument can apparently function normally in this challenging geological environment may highlight the robustness of induced magnetic susceptibility methods over the passive magnetometry methods currently favoured by archaeological geophysics (Dalan 2008:2-3). This is an encouraging result for the future of archaeological geophysics in Nova Scotia.

Nevertheless, the absence of unambiguous evidence of architecture in the geophysical data leads us to one of two interpretations: either there are no substantial architectural features in the survey area; or the surviving traces of architecture exist below the instrument's effective depth. If the former, either the large structure depicted in the ca. 1800 map (Figures 2 and 3, above) was never built - in which case the feature on the map was purely aspirational - or our survey grid was not sufficiently large to detect its remains. The best way to resolve this question is to return to the site and conduct a larger survey, this time taking care to expand the grid down-slope to the east.

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[1] Recently subdivided as the Bluestone Formation (see Jamieson, Waldron and White 2011).

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